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Research Note

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RESPONSE OF PONDEROSA PINE POLE STANDS TO THINNING

by

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ABSTRACT

Thinning dense ponderosa pine pole stands on site V in northern Washington will promote greater diameter growth per tree and greater wood production on trees that will reach usable size. Trees spaced 13.2, 18.7, and 26.4 feet apart grew in diameter at the rate of 2.0, 2.6, and 3.2 inches per decade, respectively. Comparable trees in the unthinned plots grew only 0.63, 0.68, and 0.73 inches per decade. Height increment did not differ between spacings for trees of comparable initial diameters. The closest spacing produced about 31 cubic feet per acre per year compared to 19 cubic feet at the widest spacing.

Stand density control is the forester's principal tool for speeding up growth of individual trees and concentrating wood production on those trees that will reach usable size. Thinning to provide desirable tree spacing is especially important in dense stands of sapling and small pole-sized ponderosa pine (*Pinus ponderosa*) growing on poor sites. Growth of individual trees is usually extremely slow in such stands, and wood production is diffused among a large number of stems most of which will never reach usable size.

Definition of the optimum tree spacing required to fit a given market and site condition remains elusive. This note reports first 5-year results of one of a series of spacing studies designed to help foresters choose the initial spacing that will best fit their site and anticipated market conditions.[1] [2]

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[1] Barrett, James W. Spacing and understory vegetation affect growth of ponderosa pine saplings. Pacific Northwest Forest & Range Exp. Sta. U.S. Forest Serv. Res. Note PNW-27, 8 pp., illus. 1965.

[2] Barrett, James W. Dominant ponderosa pines *do* respond to thinning. Pacific Northwest Forest & Range Exp. Sta. U.S. Forest Serv. Res. Note PNW-9, 8 pp., illus. 1963.

THE STUDY AREA

A healthy stand of 47-year-old ponderosa pine saplings and poles on site V land[3] was selected for the study (figs. 1, 2, and 3).

The study is located in north-central Washington, near the town of Winthrop. The stand is about 600 feet above the Methow River at an elevation of 2,350 feet. Precipitation averages 14.5 inches annually. The soil is a well-drained Katar sandy loam.

Figure 1.--*Control plot containing 129 square feet of basal area.*

[3] Meyer, Walter H. Yield of even-aged stands of ponderosa pine. U.S. Dep. Agr. Tech. Bull. 630 (rev.), 59 pp., illus. 1961.

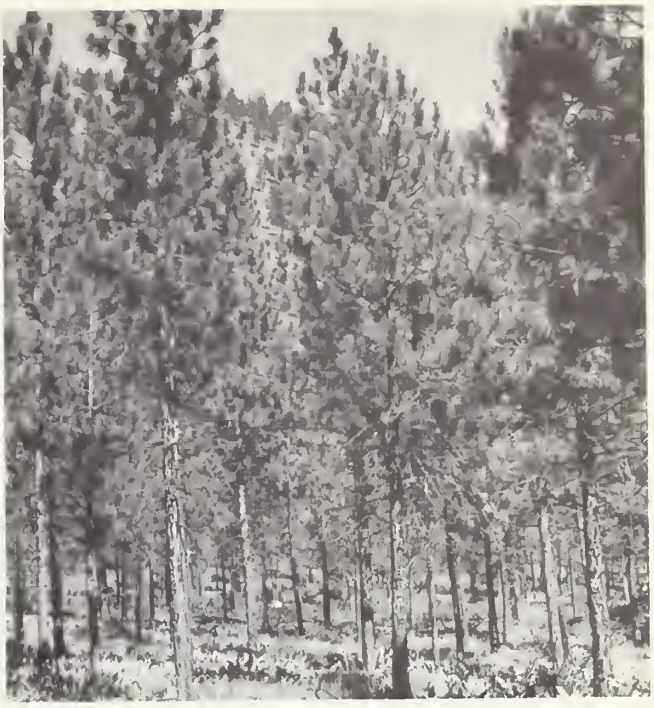

Figure 2.--*Stand thinned to 250 trees per acre.*

Figure 3.--*Stand thinned to 125 trees per acre.*

The land, owned and administered by the Washington State Department of Game, is known as the Methow Game Range. Before study installation, inspection of previously thinned stands on the game range indicated some accelerated tree growth plus improvement in forage. However, the best spacing for maximizing wood and forage production was not apparent from these original thinnings. Therefore, a combination spacing, wood increment, and forage production study was initiated.[4]

EXPERIMENTAL DESIGN AND METHODS

The experiment consists of thinning to average spacings of 13.2 feet (250 trees per acre), 18.7 feet (125 trees per acre), and 26.4 feet (62 trees per acre), and no thinning. Each treatment is replicated three times in a randomized block design, thus making a total of 12 rectangular 1/5-acre plots. Uniform spacing was sought in marking leave trees, but it was not always possible to find the best tree at the right point. However, the best tree was chosen within a radius of one-third the spacing distance from the point of ideal spacing.

All trees on the thinned plots were measured to the nearest 0.1 inch in diameter, breast high, and to the nearest 0.1 foot in height. Sample trees on each plot were climbed and diameter and bark thickness measured at 5-foot intervals up the tree. These sample trees formed the basis for calculating formulas that express volume of the entire stem as a function of diameter and height. Formulas were then used to calculate plot volumes.

Trees on control plots were tallied by diameter classes at the beginning of the period, and therefore, values shown in table 1 for age 47 are approximate. As a result, an accurate volume could not be calculated for this age, and no volume increments are reported for control plots. At age 52, all trees on control plots were measured to the nearest 0.1 inch, thus providing a base for accurate volume and volume increment estimates in the future. In addition, a sample of trees in the 52-year-old stand were climbed, measured, and volumes expressed as a function of diameter in formula form.

Thinning was done in the fall, early winter, and spring at age 47. Slash was removed from the plots and burned outside the perimeter of the plot.

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[4] A cooperative study between the Washington State Department of Game and U.S. Department of Agriculture, including the Soil Conservation Service, Okanogan National Forest, and the Pacific Northwest Forest and Range Experiment Station.

Diameter and Basal Area Increment

Spacing significantly affected diameter growth.[5] Trees at the widest spacing grew at the rate of 3.2 inches per decade compared with 2 inches where trees were spaced 13.2 feet apart (fig. 4). Released trees were evidently able to utilize the additional growing space shortly after thinning. For example, statistical tests indicate that differences between growth rates at the two widest spacings are real and not due to chance. Therefore, trees spaced at 18.7 feet are competing for soil moisture and nutrients only a few years after release.

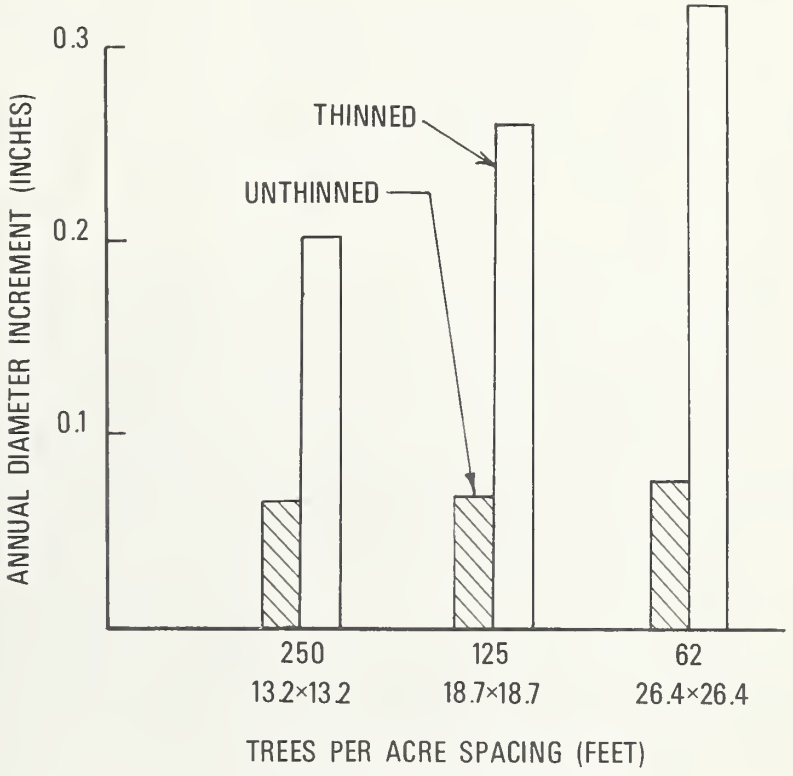

Figure 4.--*Average annual diameter increment per tree in the thinned stand and average growth on a comparable number of trees in the control plot.*

[5] Analysis of variance and orthogonal comparisons included only plots at spacings of 13.2, 18.7, and 26.4 feet. Covariance was not used because individual tree increments failed to show any significant relation to diameter at the time of thinning.

The close spacing of the trees on the control plots did not allow even the best trees to grow at acceptable rates. Diameter increment from age 47 to 52 years was determined by boring the equivalent of 62, 125, 250, and 500 evenly spaced trees per acre on each of the control plots. The 62 trees per acre are growing only slightly better than where 250 trees were selected (fig. 4), indicating that even the largest trees are suffering badly from competition.

Substantial differences exist in tree growth between control plots and thinned plots. For example, the growth rate of the best 125 trees per acre on the control plots averaged only 0.7 inch per decade compared with 2.6 inches per tree per decade on plots thinned to this density.

Basal area on all trees in the check plots is increasing at the rate of about 6 square feet per acre per year. In contrast, thinned plots are adding basal area at the rate of 2.7 square feet at the narrowest spacing and only 1.4 square feet at the widest spacing. Trees spaced 18.7 feet apart are accumulating basal area at the rate of about 2 square feet with only 5 percent of the total number of trees on the check plots.

The relative increase in basal area from one spacing to another suggests that the potential for wood production recovers rapidly after initial reduction in growing stock. To illustrate, basal area where trees are spaced at 18.7 feet (table 1) has reached 27.1 square feet at age 52, which slightly exceeds 26.8 square feet at age 47 where twice as many trees were left (13.2 feet). The same relationships are present when only the two widest spacings are considered. Maybe thinned stands similar to the one described here can accumulate a level of growing stock equal to a stand with twice as many trees in only 5 years.

Height Increment

Height growth ranged from 1.3 feet per year on some individual trees to almost no detectable growth on a few trees in the control plots. Average annual height growths per tree for each treatment were as follows:

Spacing (Feet)	Height growth (Feet)
13.2	0.64
18.7	.72
26.4	.82

For trees of comparable initial diameter, height increm
not differ significantly between spacings. Larger trees grew l
in height than smaller trees. For example, where trees averaged

Table 1.--*Average stand characteristics immediately after thinning and 5 years later (per acre)*

Spacing (feet)	Stand age	Average[1/] d.b.h.	Average[2/] height	Basal area	Volume[3/]
	Years	Inches	Feet	Square feet	Cubic feet
13.2 (250 trees per acre)	47	4.4	23.4	26.8	270
	52	5.4	26.6	40.1	424
18.7 (125 trees per acre)	47	5.0	25.7	17.4	189
	52	6.3	29.3	27.1	314
26.4 (62 trees per acre)	47	5.8	28.5	11.4	127
	52	7.4	32.6	18.4	223
4.3 (Control, 2,356 trees per acre)	47	3.0	--	93.0	--
	52	3.2	--	122.7	1,082

[1/] Diameter of tree of mean basal area.

[2/] Arithmetic mean.

[3/] Volume of entire stem, inside bark.

4.5 inches in diameter at the time of thinning, height increment was 0.6 foot per year compared with 0.9 where trees averaged 6 inches in diameter (fig. 5). The lack of influence of tree competition or spacing on height growth during the last 5 years can be further illustrated by the fact that the 62 best trees per acre on the three closest spacings (including the control plots) grew as well as trees at the widest spacing.

Past stand density has probably influenced height growth as well as diameter growth. Thus, age is important, and we would surmise that earlier thinning could stimulate height growth.

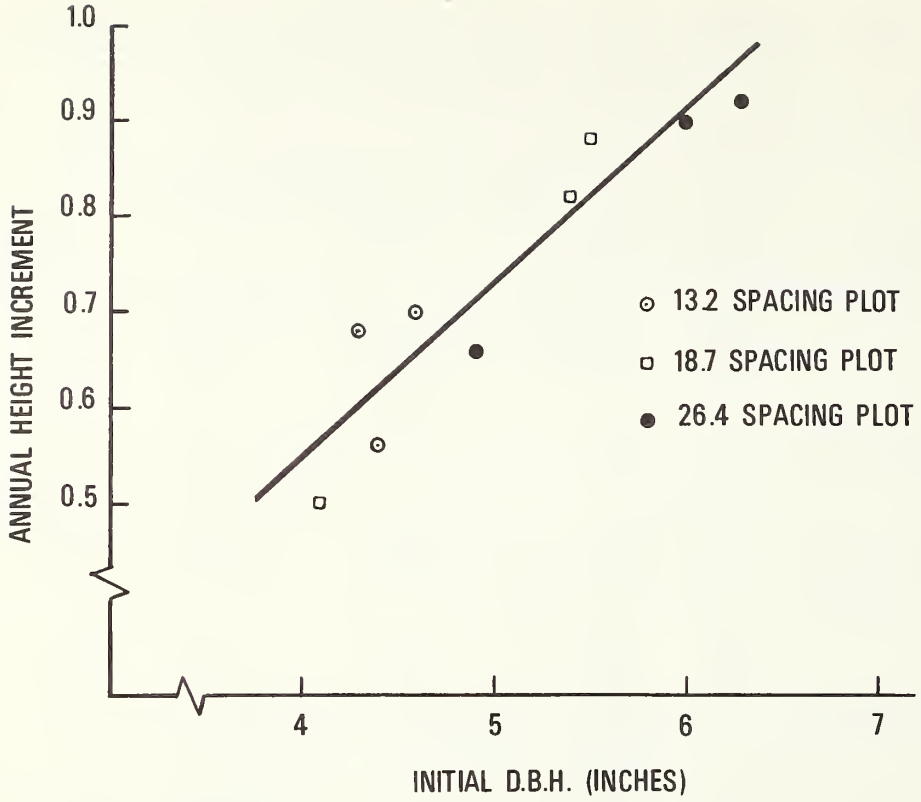

Figure 5.--*Relationship of average annual height increment to average diameter directly after thinning.*

Volume Increment

Where trees are widely spaced, some reduction in total wood production is evident. However, this reduction is not as great as some would expect (fig. 6). For example, where trees are spaced at 18.7 feet the stand is already growing 81 percent of that produced by a stand having twice as many trees (250 trees per acre). Therefore, a small sacrifice of presently unmerchantable fiber production has permitted wood accumulation on trees which are sure to reach merchantable size in less time than where a greater number of trees were left. Most of the productive capacity of the stand may recover rapidly where trees are spaced at 18.7 feet because basal area is already accumulating at the rate of 2 square feet per acre per year.

Volume increment was influenced by the size of tree that could be left. As tree size was partly a result of stand density prior to thinning, some plots having the same treatment had decidedly different average diameters after thinning. Larger trees for a given spacing

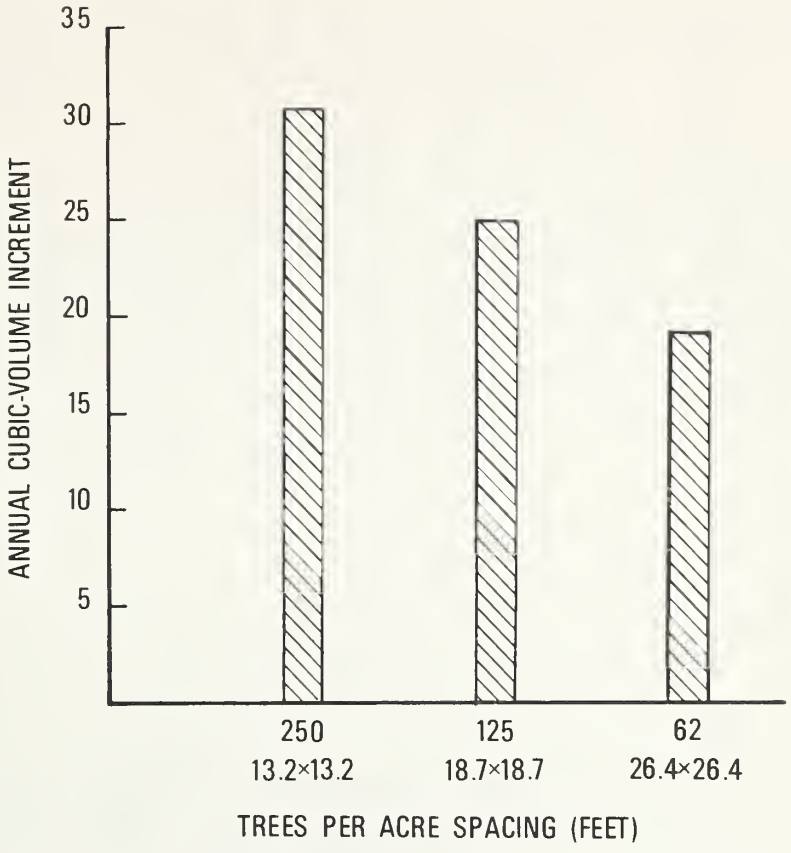

Figure 6.--*Average annual cubic-volume increment at different spacings.*

produced more volume. For example, with spacing held the same, a stand with an average diameter at the time of thinning of 6 inches produced twice as much volume as a stand averaging 5 inches in diameter.

Cubic-volume increment is well correlated with initial volume and basal area (fig. 7). Volume production is only about 15 cubic feet per acre per year where the stand was reduced to only 10 square feet of basal area per acre and a little over 30 cubic feet when cut back to 25 square feet of basal area.

Mortality

Almost no mortality is taking place in the unthinned stand. Furthermore, there is little evidence to indicate that any significant mortality has taken place for 20 years. The stand is remarkably free of insect activity and disease. No mortality was observed in the thinned stand.

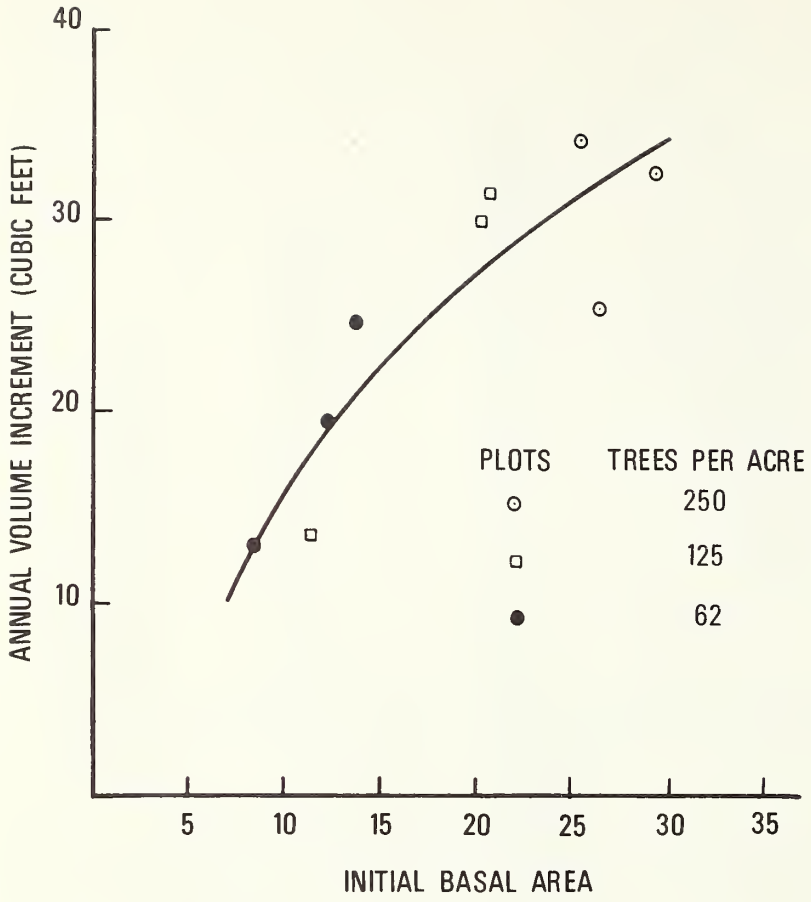

Figure 7.--*Relationship of average annual volume increment to basal area directly after thinning.*

Forage Production

McConnell and Smith[6] reporting on forage production aspects of this study, three growing seasons after thinning, found understory yield greater on thinned than on unthinned plots. They also showed that as pine canopy and stand basal area decreased with wider spacing, understory yield was increased. In addition, when crown canopy exceeded 45 percent, forbs produced more than grasses, but below 45 percent, grasses were superior producers. Initial rates of increase in understory yield were small--2 pounds for each 1-percent decrease in canopy cover or

[6] McConnell, Burt R., and Smith, Justin G. Understory response three years after thinning pine. J. Range Manage. 18: 129-132, illus. 1965.

square feet of basal area. However, these investigators believe additional growing seasons are needed for the productive capacity of the site to respond fully to timber stand treatment.

CONCLUSION

This experiment demonstrates that substantially greater diameter growth per tree and greater wood production on trees that will reach usable size may be attained by thinning site V ponderosa pine pole stands in northern Washington. Site not used by widely spaced young trees in the first years after thinning is at least partially utilized by understory vegetation. Thus, the usefulness of the forest is increased for wood and forage production.